MODULE 8
SURFACE WEATHER MAPS

OBJECTIVES

At the completion of this module, the student will be able to

1) Recognize and translate basic information from an individual station plot
2) Identify areas of moisture, temperature, and pressure discontinuity on a mesoscale surface weather map
3) Locate fronts, dry lines, thunderstorm outflow boundaries, pressure couplets, and high and low pressure centers; and identify areas favorable for the support of thunderstorm activity

INTRODUCTION

If you have lived in North Texas for any length of time, you have often heard the familiar beeps from your TV and looked to see the text scrolling across the bottom of the screen, “The National Weather Service has issued a severe thunderstorm watch for portions of North Texas, The watch area extends from Gainesville to Stephenville to Corsicana to Tyler until 1000 PM tonight.” Yet how can forecasters pinpoint the area where severe thunderstorms are likely to develop? It seems like a pretty amazing feat when you realize that our severe storm forecasters must decide on a relatively small area from national weather maps which have very large data resolutions.

One of the key elements which forecasters use to “fine tune” their placement of watch boxes is a surface weather map. The weather map is plotted by a computer utilizing a coded weather observation which is collected 10 minutes before every hour, 24 hours a day, and more frequently during critical weather situations.

PLOTTED STATION DATA

A computer translates the surface observation into the form of a station plot and places it in the correct geographic location on a selected area map. The primary challenge in plotting weather data on a map is to include as much information as possible in as small an area as possible in a format which can be understood by meteorologists around the world. Figure 8-1 is the symbolic form of a surface observation as charted by the station plot program.

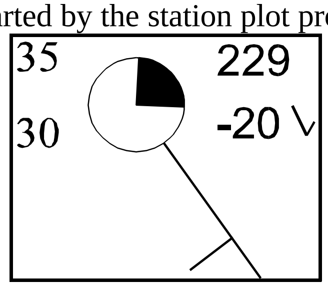
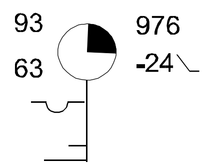


Figure 8-1: Station plot example.

The following exercise and tables will show you how to decode and interpret plotted station data. As with contour analysis, this may seem very foreign to you at first. With practice, you will become more comfortable with the station plot and the various symbols used on the maps. This exercise is very important as all of our hourly and upper air map data is plotted in this format. The tables in this section, Figures 8-2 through 8-6, can be pulled out to be used in the classroom map exercises.

SAMPLE DECODING EXERCISE

Let's decode the station model plot shown below:



SOLUTION

The sky condition is indicated by the fraction of coloration in the circle. In this example, 1/4 of the circle is shaded which indicates scattered cloud cover. Clear skies would be indicated by a clear circle, while overcast skies would be indicated by a black circle. The symbol below the circle represents the low cloud type. From the Cloud Code Group table, we see this is "Stratocumulus not formed by the spreading out of Cumulus".

The wind barbs indicate that the wind is 13-17 knots or 15-20 miles an hour. The direction of the wind is represented by the staff to which the wind barbs are attached like the direction post of a wind vane. The tail of the wind vane is located by the barbs with the head of the wind vane being the circle denoting the station. The wind blows from the tail to the head so in this example the wind is blowing from the South to the North and represents a South wind.

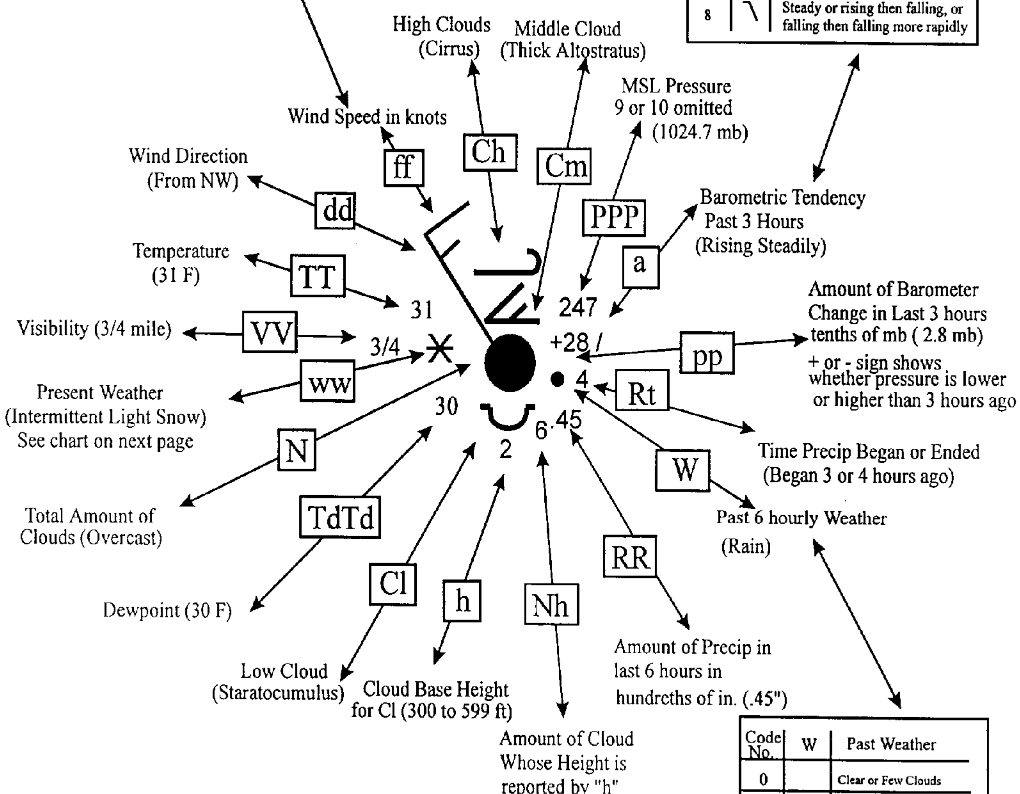
The temperature is located on the upper left and is 93 degrees. The dew point temperature is located on the lower left and is 63 degrees. Temperatures and dew points are typically plotted in degrees Fahrenheit on surface maps.

The sea level pressure is on the upper right. Pressure is typically plotted in tenths of millibars with the leading 9 or 10 omitted. Huh? It's actually easier to illustrate than it is to explain. In the example, the 976 represents 997.6 mb. A plotted pressure value of 013 would represent 1001.3 mb. A value of 245 represents 1024.5 mb.

The -24 represents the barometric change in the last 3 hours. -24 indicates the pressure fell 2.4 mb in the past three hours. The L-shaped symbol indicates the barometric tendency. From the Barometric Tendency chart in Figure 8-2, we read this as pressure falling then became steady, or falling then falling more slowly, over the past three hours.

ff	Miles (Statute) per hour	Knots	ff	Miles (Statute) per hour	Knots
	Calm	Calm		50-54	43-47
	1-2	1-2		55-60	48-52
	3-8	3-7		61-66	53-57
	9-14	8-12		67-71	58-62
	15-20	13-17		72-77	63-67
	21-25	18-22		78-73	68-72
	26-31	23-27		84-89	73-77
	32-37	32-37		90-94	78-82
	38-43	33-37		95-100	83-87
	44-49	38-42		119-123	103-107

Code No.	a	Barometric Tendency
0		Rising then falling, same or higher than 3 hours ago
1		Rising then steady, or rising, then rising more slowly
2		Rising, steadily or unsteadily
3		Falling or steady then rising, or rising then rising more rapidly
4		Steady, same as 3 hours ago
5		Falling then rising, same or lower than 3 hours ago
6		Fallingthen steady, or falling then falling more slowly
7		Falling, steadily or unsteadily
8		Steady or rising then falling, or falling then falling more rapidly



Code No.	W	Past Weather
0		Clear or Few Clouds
1		Partly Cloudy (scattered) or variable sky
2		Cloudy (broken) or overcast
3		Sandstorm or Duststorm or drifting or blowing snow
4		Fog,smoke, or thick dust haze
5		Drizzle
6		Rain
7		Snow or Rain and Snow mixed, or ice pellets(sleet)
8		Shower(s)
9		Thunderstorm, with or without precipitation

Figure 8-2: Station plot decoder.

Cloud Code Groups (Cl, Cm, Ch)

	Cl (low level)	Description		Cm (mid level)	Description	Ch (high level)	Description
1		Cu of Fair Weather, little vertical development and seemingly flattened	1		Thin As(most of cloud layer semi-transparent)		Filaments of Ci, or mares tails scattered and not increasing
2		Cu of considerable development, generally towering, with or without other Cu or Sc bases all at same level	2		Thick As,greater part sufficiently dense to hide sun sun(or moon) or Ns		Dense Ci in patches or twisted sheaves usually not increasing, sometimes like remains of Cb;
3		Cb with tops lacking clear cut outlines but distinctly not not cirriform or anvil-shaped; with or without Cu,Sc,or St	3		Thin Ac,mostly semi-transparent; cloud elements not changing much at single level		Dense Ci, often anvil shaped, derived from or associated with Cb
4		Sc formed by spreading out of Cu; Cu often spreading over the whole sky	4		Thin Ac in patches;cloud elements continually changing and/or occurring at more than one leve		Ci,often hook shaped, gradually spreading over sky and usually thickening as a whole
5		Sc not formed by spreading out of Cu	5		Thin Ac in bands or in a layer gradually spreading over sky and usually increasing as a whole		Ci and Cs, often in converging bands or Cs alone; generally overspreading and growing denser ; the continuous layer not reaching 45 degrees altitude
6		St or Fc or both, but no Fc of bad weather	6		Ac formed by the spreading out of Cu		Ci and Cs, often in converging bands or Cs alone; generally overspreading and growing denser ; the continuous layer exceeding 45 degrees altitude
7		Fc and/or Fc of bad weather (scud)	7		Double layered Ac or a thick layer of Ac, not increasing; or Ac with As and/or Ns		Veil of Cs covering the entire sky
8		Cu and Sc (not formed by the spreading out of Cu) with bases at different levels	8		Ac in the form of Cu shaped tufts or Ac with turrets		Cs not increasing and not covering the entire sky
9		Cb having a clearly fibrous (cirriform) top, often anvil shaped, with or without Cu, Sc, St or scud	9		Ac of chaotic sky, usually at different levels; patches of dense Ci are usually present		Cs alone or Cc with some Cl or Cs, but the Cc being the main cirriform cloud

LOW CLOUDS Cu- Cumulus Cb- Cumulonimbus Fc- Fractocumulus Ns- Nimbostratus Sc- Stratocumulus
MID CLOUDS Ac- Altocumulus As- Altostratus HIGH CLOUDS Ci - Cirrus Cs- Cirrostratus Cc- Cirrocumulus

Figure 8-3: Cloud code groups.

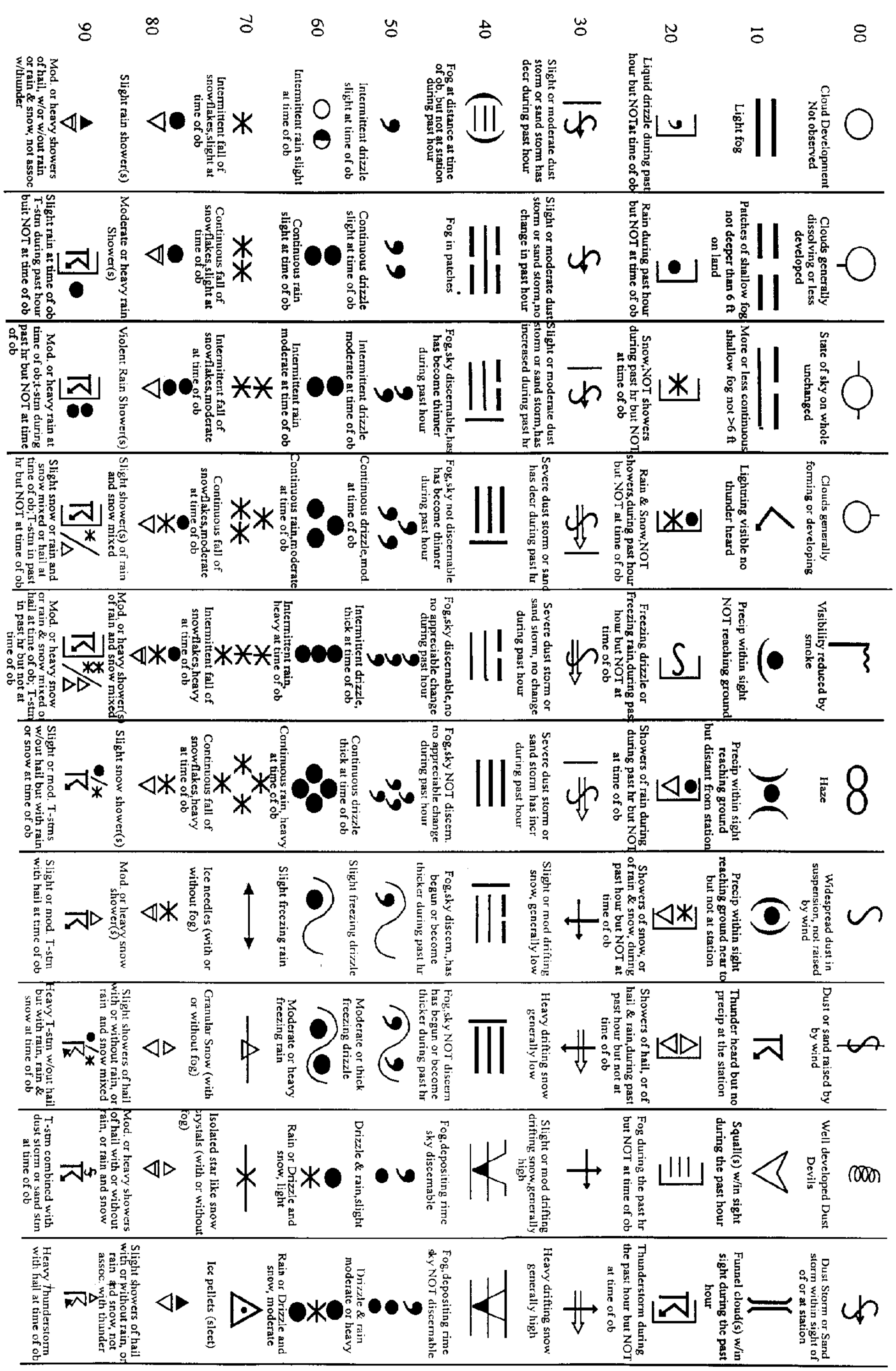


Figure 8-4: Present weather codes.

H

High pressure area. Colored blue and placed over the center of high pressure, NOT NECESSARILY the highest observed pressure.

L

Low pressure area. Colored red and placed over the center of low pressure, not necessarily the lowest observed pressure.

Cold front. Colored blue, oriented with "teeth" pointing from cold air to warm air.

Warm front. Colored red, oriented with circles pointing from warm air to cold air.

Stationary front. Colored alternating red and blue ("teeth" in blue, circles in red).

Trough. Oriented along line of lowest pressure, colored purple.

Dryline. Colored brown, semicircles point from dry air to moist air.

Outflow boundary. Colored purple. Some analyists place small cold front "teeth" on longer dashes.

Figure 8-5: Other map symbols.

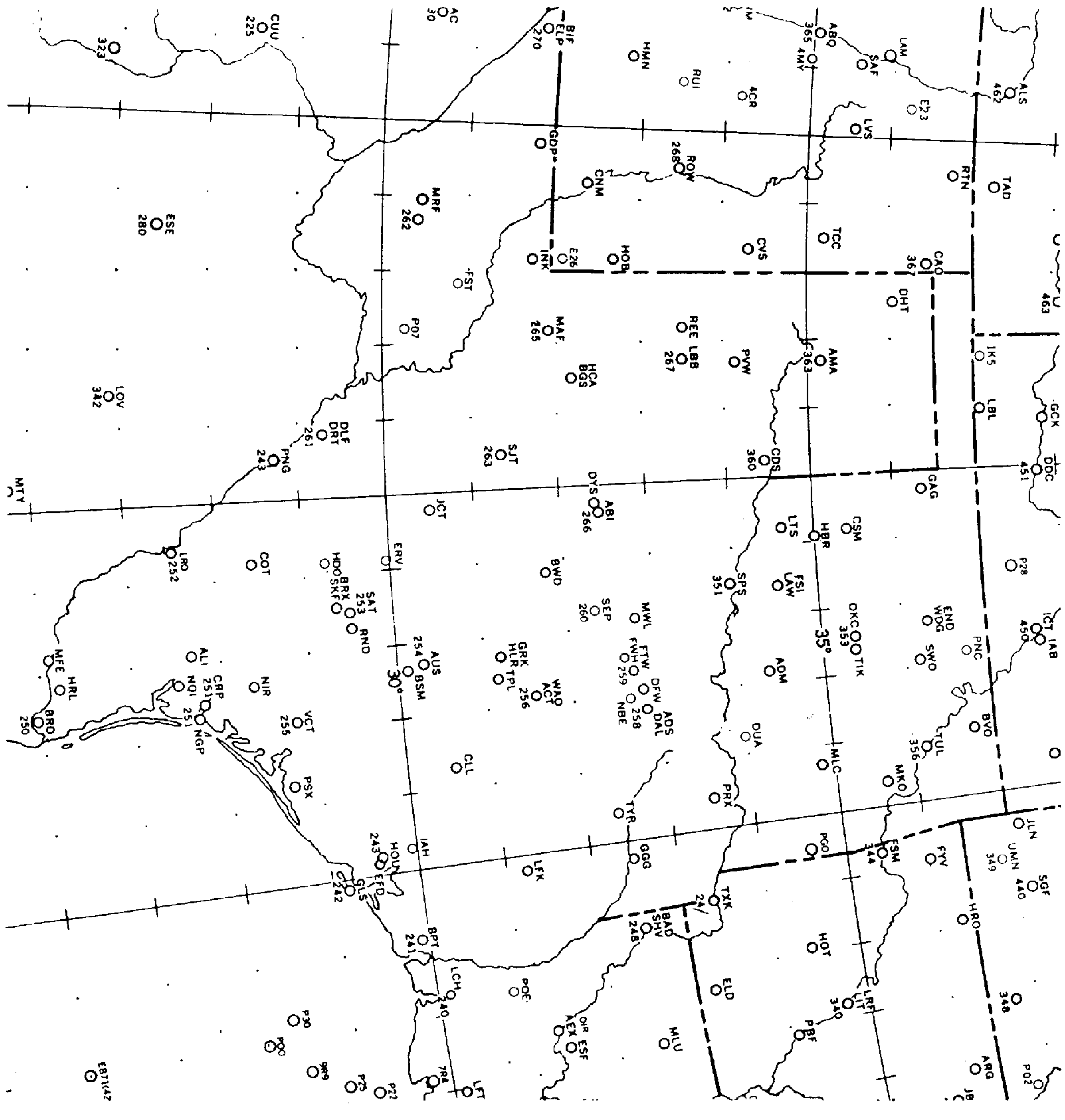


Figure 8-6: Station locations.

THE SURFACE MAP

After all of the observations are plotted on an area map, forecasters analyze a variety of parameters to determine just what the weather is doing across the area. For this module we will use the area covered by the states of Texas, Oklahoma, Kansas, Louisiana, and New Mexico.

We will use the plot decoding skills we learned earlier in this module and the contouring techniques we developed in Module 7 to analyze this map. When we have finished, we should have a relatively good idea what is taking place weatherwise across the area.

A few quick reminders regarding the station plots:

- Temperature is on the upper left.
- Dew point temperature is on the lower left.
- Pressure is on the upper right.
- Cloud cover is reflected by the amount of color in the station circle.
- Lines coming out of station circles represent direction FROM WHICH wind is blowing.
- Long feather on wind direction line is 10 knots, short feather is 5 knots.

Before beginning our contouring, let's study the map for a couple of moments and see if anything jumps out at us. Scan the wind field shown on the map. Is there anything noteworthy? Does anything show up in the temperature reports? How about the current weather observations (plotted just beneath the dew points)? We'll look at these features in more detail as we move through the contour analyses. Analysts often like to simply scan over the map before starting their contouring to get a "feel" for the data they will be analyzing.

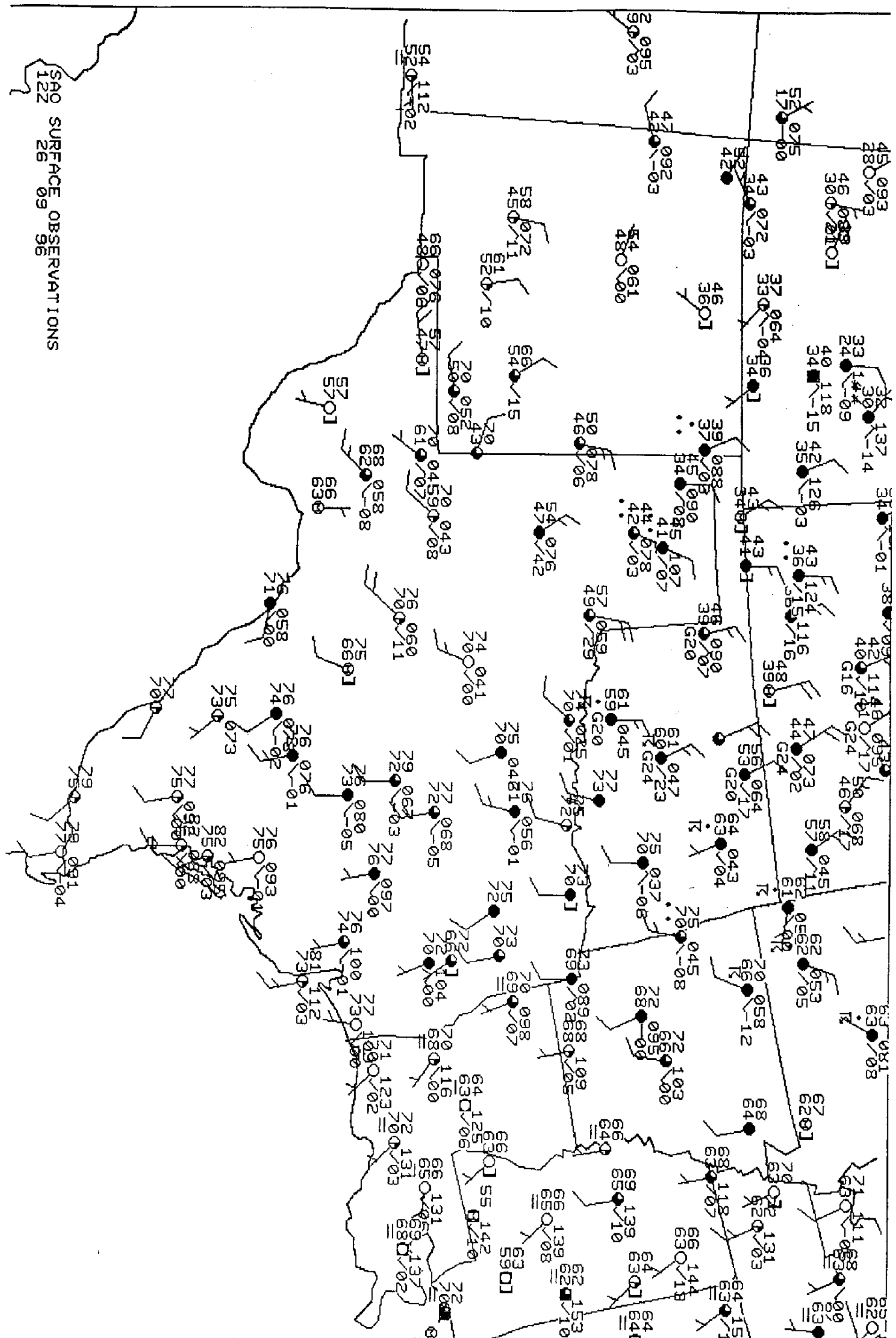


Figure 8-7: Base regional surface map.

TEMPERATURE ANALYSIS

Every analyst has a different method for drawing contours. Some like to draw the pressure contours first, while others like to first place the frontal boundaries. Still others prefer to draw the dew point contours first. As you gain experience in map analysis, you will likely develop your own style. No one will fault you for using your own method, as long as you are comfortable with it and as long as it gets the job done.

In this example, we will start with the temperature field. This is done by contouring the temperature values which, again, are found to the upper left of the station circle.

Temperature contours are called **isotherms**. You may start with any temperature value you choose. The goal is to make the contours smooth and to highlight the highest temperatures. Many analysts start with a value which will bullseye the highest values. The first isotherm we will draw will be for 75 degrees. Temperatures are usually contoured in 5 degree increments so our isotherms will be for 75, 70, 65, 60, 55, 50, etc..

We draw our 75 degree isotherm so that the temperature values of 75 degrees or higher are located inside of the line and those less than 75 degrees are outside the line. Examine the 70 degree contour. Those stations which are located in the area between the 70 and 75 degree isotherms have temperature readings between 70 and 75 degrees. This same logic follows for the 65 degree isotherm with the stations located between the 65 and 70 degree isotherm having temperatures between 65 and 70 degrees. If a station has a temperature value which equals the value of the isotherm, then the contour will go through (or very close to) the circle of that station. The completed temperature analysis is shown in Figure 8-8.

Okay, we've drawn a bunch of lines on the map. Now what? A couple of items are evident from the temperature field. First, a "hump" in the temperature contours, called a **thermal ridge**, extends from south Texas into eastern Oklahoma and western Arkansas. A smaller thermal ridge extends into southeastern New Mexico. Remember our discussion of thunderstorm building blocks back in Module 2? One of the ways to destabilize the atmosphere, making it more favorable for severe thunderstorms, was to heat the air near the ground. We might suspect this is taking place near the thermal ridges.

Notice the relatively tight packing of isotherms from western Texas across northern Oklahoma to southern Missouri. This suggests that we have a fairly strong **temperature gradient** in the area, with temperatures cooling rapidly over a short distance. This combined with the wind field (strong north winds over northwest Oklahoma, south winds over north Texas) suggests that a cold front is moving across the area. This front is a good candidate to lift the relatively warm low-level air and generate thunderstorms.

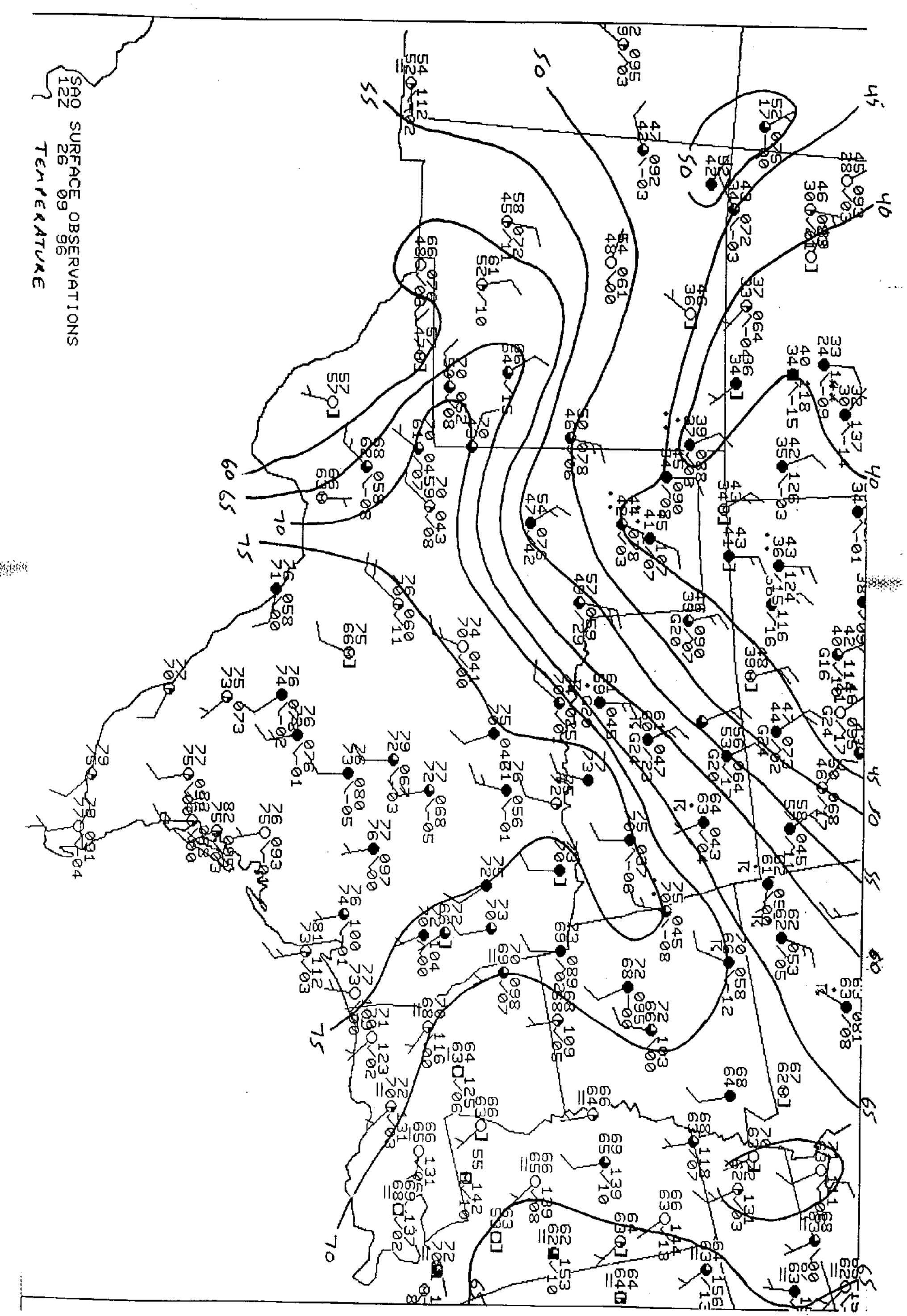


Fig 8-8: Regional temperature analysis.

8-11

DEW POINT ANALYSIS

Next, let's contour the dew point field. Dew point contours are called **isodrosotherms**. Again, we'll start with the highest dew point contour value, which for this map is 75 degrees. We'll work our way down in 5 degree increments so the isodrosotherms will be 75, 70, 65, 60, etc..

The process is very similar to the temperature analysis on the previous pages. The dew point values of 75 degrees or higher are located inside of the line and those less than 75 degrees are outside the line. Isodrosotherms which equal the observed value of a station will pass through (or very near) the observation circle of that station. The completed dew point analysis is on the next page as Figure 8-9.

As with the temperature analysis, a couple of items are evident from the contoured dew point field. First, a "hump" in the dew point contours, called a **moisture ridge**, extends from south Texas into eastern Oklahoma and western Arkansas. Look back at the temperature analysis. This is almost identical to the location of the thermal ridge. Thinking back to Module 2, another method of destabilizing the atmosphere was to add moisture to the layers of air close to the ground. The low-level air in the region from southern Texas to northwest Arkansas has been both warmed and moistened relative to the surrounding areas. This area is looking more and more favorable for significant thunderstorm development.

Notice the relatively tight packing of isodrosotherms from southwest Texas to southeastern Kansas and southern Missouri. This suggests that we have a fairly strong **moisture gradient** in the area, as dry air moves into the region behind the cold front. This moisture change, coupled with the temperature change and wind field, again suggest that the front is a good candidate to lift the relatively warm low-level air and generate thunderstorms.

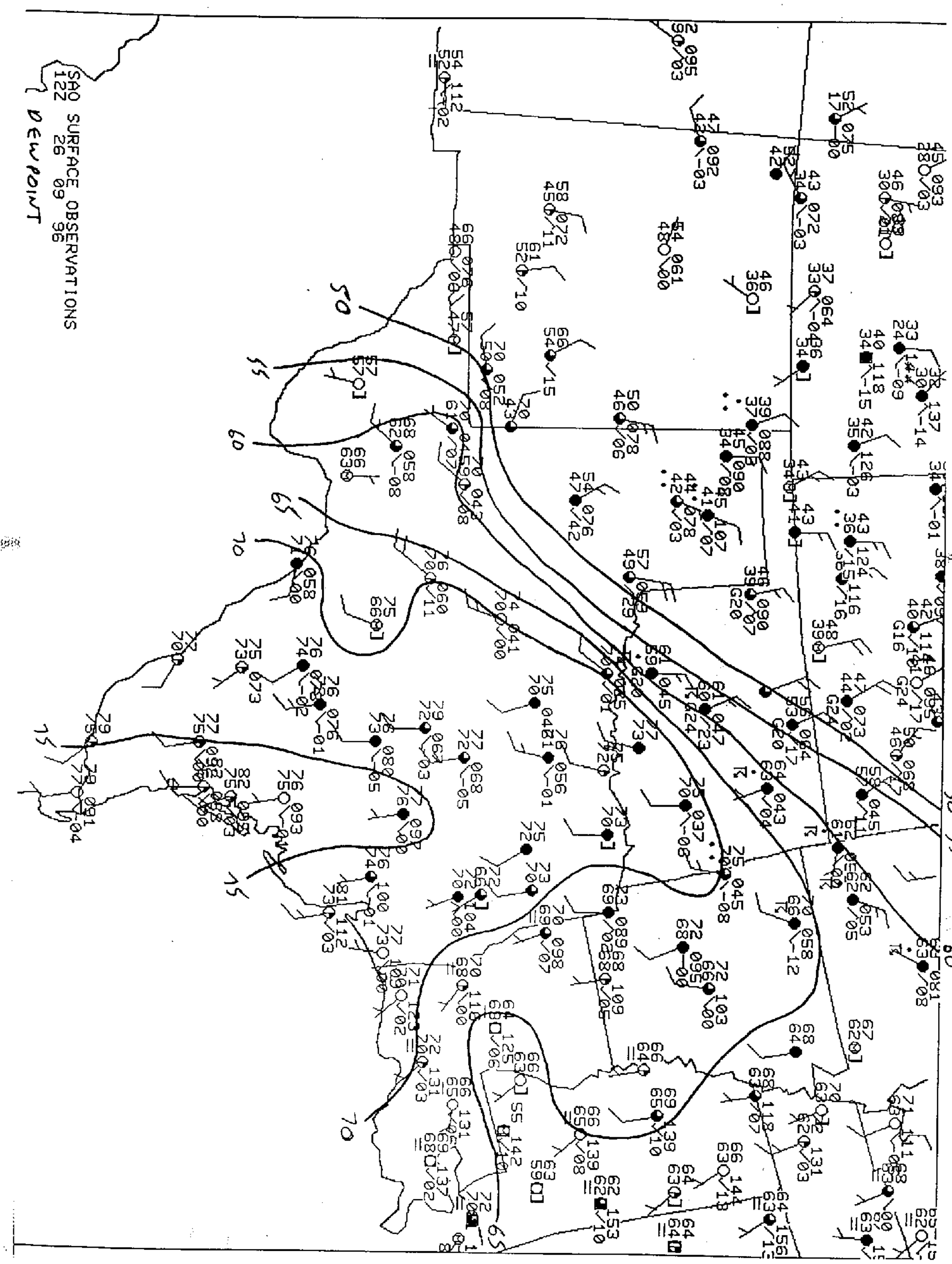


Figure 8-9: Regional dewpoint analysis.

PRESSURE/FRONTAL ANALYSIS

The final step in producing our surface map is a contour analysis of the pressure field and placement of the fronts, pressure centers, and other boundaries which may be present. Pressure contours are called **isobars**. These are commonly drawn at 4 millibar intervals on national maps, but for the regional-scale maps we will be using, a 2 millibar interval will allow us to see smaller scale, but very important, features.

First, let's place the frontal boundary. It's easy in this example to see where it lies. We have a well-pronounced wind shift, a strong temperature gradient, and a fairly strong moisture gradient near and just behind the frontal boundary. The front extends from southwest Texas across southern and central Oklahoma to central Missouri. It appears that the front has pushed a little farther south in western Oklahoma than it has in the east. This may suggest a weak low pressure area is forming along the front in central Oklahoma. The pressure contours will confirm whether or not this low pressure area exists.

Now, let's draw the isobars. The first isobar we will draw will be for 1004 millibars (040 on the station plots). We're doing things a little differently on this analysis in that we're starting with the lowest contour value and working our way up. You can start with any value you wish, however starting at one extreme or the other will produce a smoother analysis. Recall in Module 7 we stated that almost all contours will be smooth. Here is the exception. When drawing pressure contours across a frontal boundary, analysts often "kink" the isobars to represent the sharp wind shift and airmass change. Note the sharp turns in the 1004 and 1006 millibar isobars at their intersection with the front.

Finally, we can place the pressure centers based on the isobars. A high pressure center is evident in eastern Colorado and northwestern Kansas. A low pressure center is evident somewhere in central Oklahoma, perhaps a little southwest of where it is drawn on the map. The completed analysis is shown in Figure 8-10.

Based on all of these analyses, what might we expect? The cold front has fairly strong (15-20 knot) north winds behind it, with south winds of 10-15 knots ahead of it. Thus, the front should continue to move southward into warm, moist low-level air. Lift along the front may initiate thunderstorm development; indeed, thunderstorms are currently being reported at observing stations from Wichita Falls, Texas across Oklahoma and into central Missouri.

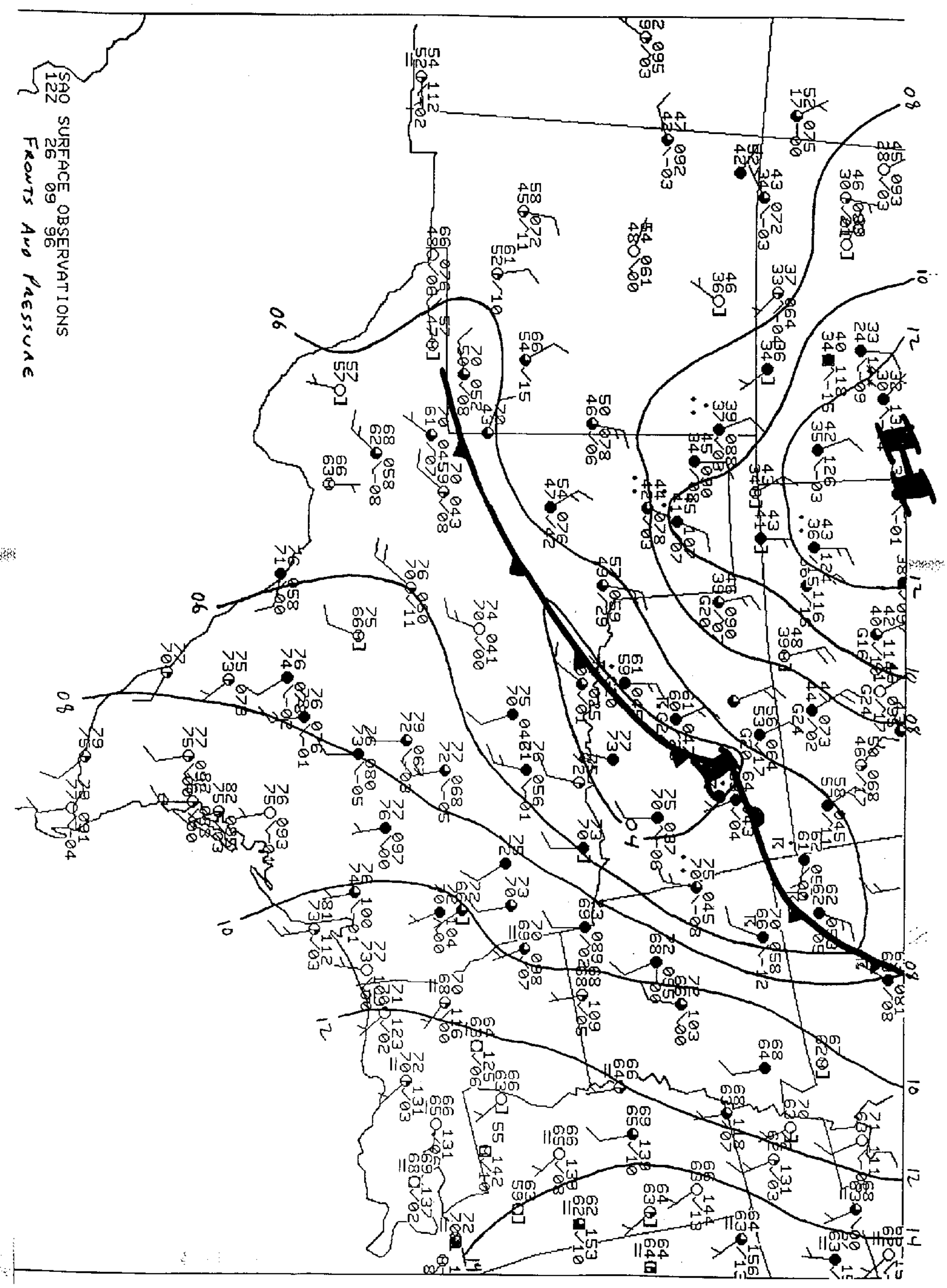


Figure 8-10: Regional pressure/frontal analysis.